

09/242072

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(Mrs) Anne HAMMETT

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	International Application No.	Other Information
IPER	PCT/AU96/00442	Miller; Peter Anthony

Total : 8



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

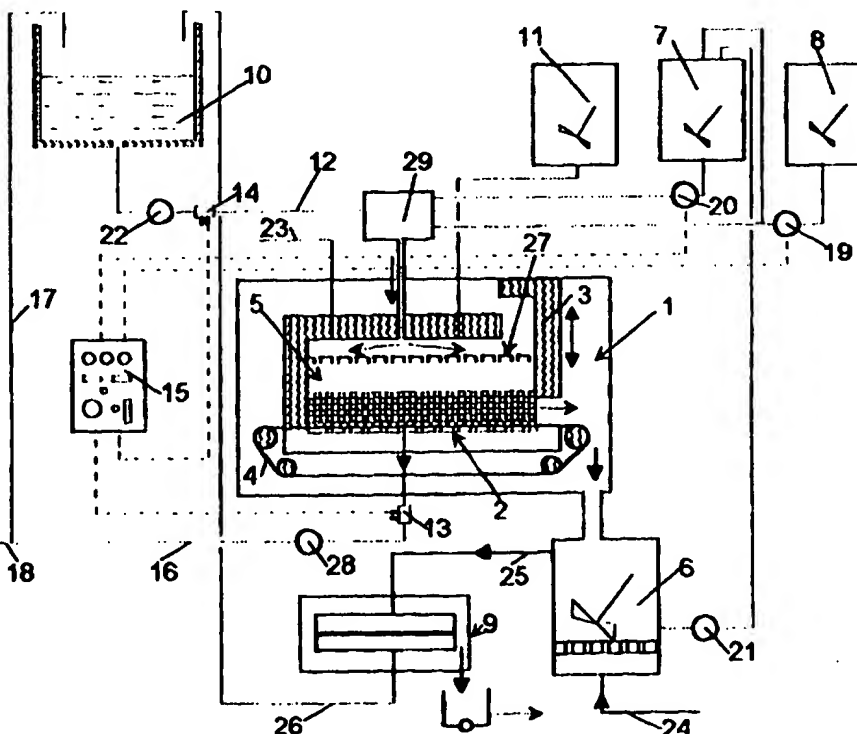
(51) International Patent Classification ⁶ : B01D 24/46, 29/96, 41/02	A1	(11) International Publication Number: WO 98/05402 (43) International Publication Date: 12 February 1998 (12.02.98)
(21) International Application Number: PCT/AU96/00442 (22) International Filing Date: 5 August 1996 (05.08.96) (71)(72) Applicant and Inventor: MILLER, Peter, Anthony [AU/DE]; 91 Bunya Park Drive, Eatons Hill, 4037 (AU).	(81) Designated States: AU, BR, CA, CN, CZ, FI, HU, JP, MX, NO, NZ, PL, SG, SK, US, Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE). Published With international search report.	

(54) Title: APPARATUS FOR LIQUID PURIFICATION

(57) Abstract

The invention concerns a liquid purifying apparatus that bridges the gap between prior art sand filters as applied mainly in the field of water treatment and pressure leaf, candle and cartridge filters as well as filter presses for filtration and purification in the liquid processing industries. In contrast to prior art sand filters where static beds of granular material are regenerated by backwashing techniques, the granular beds of the present invention are transported out of the filter container by a moving filter belt into an external bed-regenerating device after which the regenerated and reactivated bed is reused by dosing to the filter container with the incoming fluid to be purified. It is proposed to simultaneously dose a variety of active powdered adsorbents, such as activated carbon, molecular sieves, etc., to the purifier influent to remove specific dissolved contaminants, whereby the surface charge and particle size of this material are designed to adhere to the surface of the particulate matter of the bed. The dosing of active adsorbents and the particulate matter of the bed is

controlled by a programmed microprocessor receiving input process data from influent and effluent instrumentation. A further feature is the provision of apparatus for feeding prefabricated sections of filter media such as membranes, non-woven and woven materials into the filter container for application in fully automatic operation throughout the whole spectrum of industrial and communal liquid purification processes.



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APPARATUS FOR LIQUID PURIFICATION

Description

This invention concerns apparatus for the purification of liquids. By purification is meant the removal of unwanted suspended, colloidal or dissolved substances from a liquid.

The prior art of apparatus to achieve this consists of a large variety of generically related filters that utilize over-pressure and/or under pressure to provide the necessary pressure difference for filtration.

For the purification of liquids, filter presses or pressure leaf, candle and cartridge filters (pressure vessels containing such elements) are mainly utilized. Such liquids are chemicals, pharmaceutical products, beer, wine, sugar, oils and fats, petroleum products, etc. Their purification normally involves some form of "in-depth" filtration or purification process, whereby the liquid to be purified is either passed through or forms thereby a bed of particulate purification aid whereby the separation mechanism is mostly a combination of sieving-action and adsorption. The purification aids that are used include diatomaceous earth (kieselguhr), bleaching earth, ion-exchange resin, activated carbon, etc., all normally in powder form. The solid residues can rarely be regenerated and their disposal poses an acute environmental problem.

On the other hand, using apparatus of the nutsche-type filter in the form of open or closed containers, water is filtered by means of gravity or over-pressure on a large scale by means of thick, static beds of coarse granular material (e.g. sand). These beds are regenerated after filtration by backwashing techniques and reused. Although this method is suitable for the filtration of relatively clean surface and ground water, it is wholly unsatisfactory for the purification of industrial and domestic effluent. The reason is that the back-washing and regeneration techniques of prior art sand filters

- are inadequate for washing out most of the large variety of suspended solids contained in industrial liquid effluent

and

- produce excessive amounts of contaminated backwash liquid.

Added to this, the static nature of the beds is unsuited for the filtration of particulate matter, as large sections of the bed remain unused and the necessity for utilizing relatively coarse granular material comprising the beds for removing organic and inorganic contaminants in solution precludes on economic grounds the possibility of utilizing the extensive range of available adsorbents comprising such materials as activated carbon, anthracite, ion-exchange resin, bleaching earth, molecular sieves, etc. required for removing specific contaminants in the field of effluent and water purification.

The goal of this invention is to further develop the art and science of "in-depth" filtration utilizing beds of loose material for the purification of liquids such as processed by the

-2-

above named industries, whereby the beds are regenerated and reused more effectively than with prior art methods, resulting in a considerable reduction in the quantity of liquid and solid waste for disposal. Considering the present practice, in both the industrial and communal sector, of discharging effluent to the natural environment that is incompletely purified, the further goal is to provide these sectors with an effluent and water purification apparatus that will enable liquid effluent to be recycled and polluted water to be rendered suitable for domestic and industrial purposes.

It is proposed that the apparatus of the invention will be far more compact and versatile compared with the prior art in that it can be installed not only in large industrial and communal plants, but also in the medium to small size industrial sector. This will be achieved by utilizing specific through-puts 10-100 times those normally employed by prior art filters. Specific through-puts of 50-200 m³/m².h will be possible because the beds will be maintained in an "open" condition throughout the filtration and/or purification cycles. A further goal of the invention is to provide the liquid purification apparatus of the invention with the means for automatically selecting and applying varying types and grades of filter media and modes of operation according to the nature, filtration characteristics and requirements of any type of liquid purification operation, whereby no further distinction will be made between effluent, water and process liquid purification. The ultimate aim of the invention is to reduce the number of purification steps presently required for process liquid purification, whereby waste generation will be reduced and the purification media regenerated and reused, thus enhancing the competitiveness of these industries and simultaneously relieving the present impact on the environment. The aim of the invention with industries presently using liquids in their production processes for such operations as plating, dyeing, washing, coating, pickling, quenching, etc. is to provide the means for continuous regeneration to avoid the necessity for dumping into the environment.

THE INVENTION

Fig.1 is a schematic flow-sheet of the apparatus of the invention that consists of a purifying filter plant 1, comprising essentially a lower stationary filtrate chamber 2 with a porous upper surface on which a section of an intermittently movable filter belt 4 is supported which in operation is stationary and sealed at the periphery by vertically movable dependent rim portions 3 of an upper contaminant container 5 fitted with a conically perforated feed distributor 27 extending over the entire upper horizontal section, a bed regeneration apparatus 6, a bed material storage/dosing vessel 7, a filter aid suspension tank 11, one or more adsorbent storage/dosing devices 8, a reservoir for liquid to be purified 10 and a residue filter 9.

Filter aid suspended in liquid in tank 11 is dosed into the vented container 5. While the pressure difference between the container 5 and the lower filtrate chamber 2 is raised, liquid to be purified in reservoir 10, which may be dosed with flocculating

substances such as polyelectrolytes, is pumped using means 22 from reservoir 10 into container 5. Simultaneously, suspensions of bed material recycled from regenerator 6 and activated powdered adsorbents are dosed using means 7/20 & 8/19 under pressure to a mixing section 27 of the delivery conduit 12 controlled by microprocessor 15 from input data from instrumentation 14 and 13 in the delivery conduit 12 and the filtrate conduit 16 respectively. The liquid quality and process parameters (concentration) controlled include turbidity, pH, hardness, chlorinated organics, mineral oil, heavy metals, phosphates, nitrates, etc. as well as variables such as pressure difference and through-put. Filtrate is recycled, if necessary by means of a suction/vacuum pump (28), through conduits 16 & 17 to reservoir 10 until the concentration of contaminants in the filtrate is reduced to a set level as measured at 13. Filtrate flow is switched to conduit 18 whence it is collected in a reservoir not shown. On either reaching a pre-set pressure differential across the bed or a pre-set upper level of contaminant concentration as measured by instrumentation 13, pump 22 and all dosing apparatus are shut down and external gas is fed through conduit 23 to container 5 whereby the residual liquid in the chamber and bed is removed, after which the dependent rim portions 3 of container 5 are raised and the bed is transported by the filter belt 4 and discharged into the bed regenerator 6. The dependent rim portions 3 are lowered onto a fresh section of belt and the cycle described above is repeated. The regenerator 6, in effect, removes adsorbate and entrapped particulate matter (ultrasonics, turbulence, diffusion, etc.) from the internal and external surfaces of the granular material, which may be an adsorbent itself, thereby regenerating, cleaning and restoring the desired activities to these surfaces. Clean liquid is introduced to 6 through conduit 24 and by means of hydraulic classification action the adsorbate and particulate matter are removed through conduit 25 to filter 9 to recover a solid waste. Depending on its nature, the recovered fluid is recycled to 10 or reprocessed. Not shown are the means for introducing and removing the bed regenerating and reactivating fluids to and from bed regenerator 6. Fig.2 is a schematic representation of a partly sectioned elevation of media feeding mechanisms of the invention. Prior art filters have the disadvantage that a replacement of filter media involves lengthy shut-down periods and often excessive manual manipulation. A further goal, therefore, of the present invention is to provide the means for automatically and quickly fitting a large variety of prefabricated materials (e.g. membranes, paper, carton, etc.) to fulfill the requirements of the liquid processing industries. Pressure cylinders 215, normally taking the form of hydraulic or pneumatic rams are provided for actuating the dependent rim portions 3 of the filter container 5 in the vertical direction for bed removal and container closure.

A plurality of rolls of filter media 209, 210 are provided for feeding sections onto the lower filtrate chamber 2. Drive rollers 220, 221 located on the surface of the media rolls and actuated by a brake/clutch mechanism 225 driven by the filter belt 217 through idle

rollers 207, feed lengths of filter band over guides 223 into the rollers 207 onto the surface of the moving filter belt 217. Belt sensor 218 shuts down the belt drive motor 216 and actuates the band slitting mechanism 208 after which the section of filter medium and the supporting filter belt are finally positioned in the container 5 and the depending rim portions of the container are lowered to seal the periphery of said sections. After filtration the used sections of filter medium are normally transported out of the container 1 for disposal.

Cassettes 212, located externally to the filter container 1, are designed to feed pre-cut, pre-fabricated sheets of various types of filter media such as membranes, paper, carton, etc. into the filter container for filtration. Individual sheets are taken from the top of spring-loaded bundles 223 by means of actuated rubberized rollers 213 and fed on guides 224 to synchronously driven feeder belts 214, whereby after positioning on the porous upper surface of the filtrate chamber 2, the dependent rim portions 3 of the container 5 are lowered to seal both the belt and the overlying section of filter medium. After the filtration operation the material is transported out of the container 1 for disposal.

Fig.3 is a sectioned drawing showing an improved method for ensuring that the dependent rims 3 when they take the form of peripheral, integral sides of the container 5 are actuated in the horizontal orientation when raised and lowered and that the full thrust of the fluid driven pistons in cylinders 215 is exerted when sealing the container 5 against the horizontal pervious base 2. The bodies of the cylinders 305 are fixed to an external load-bearing framework 306 with the external extremity of the lubricated shafts 307 connected to the lower ends of vertically sectioned cylindrical sleeves 301 extending and fixed at the top end to transverse beams 308 that in turn actuate thrust shafts 303 acting directly through seals onto the top peripheral part of the container 5. Annular sections of guiding plastic material 302, preferably out of polytetrafluorethylene, are fixed to the surface of the cylinders fitting into the space between the surface of the cylinders and the inner surface of the reciprocating sleeves 302.

Fig.4 is a schematic representation of apparatus of the invention for:

- automatic selection of filter media;
- automatic selection of the optimal mode of filtration or purification;
- automatic measurement of the permeability of sections of filter media;
- automatic regeneration of partially 'blinded' sections of filter media.

A typical procedure according to the invention for the filtration or purification of a quantity of liquid of unknown filtration characteristics is the following:

A liquid is to be clarified, whereby the filtrate in the filter residue (cake) is to be recovered by a washing operation. The required degree of clarification in units of turbidity

is known. This and other pertinent information are entered into the programmed microprocessor 15 and the following sequence of operations proceeds fully automatically:
Start:

1. A section of 10 micron retention filter paper from 212 is automatically fed into the filter container.
2. The dependent rim portions of the container 5 are lowered to seal the section of paper lying on the filtrate chamber.
3. The differential pressure controller 404 establishes a preset pressure differential between the chamber sealing space 402 and the filtrate chamber 403.
4. With the container 1 vented, approx. 15 l/m² of the suspension are introduced to the top container 5 and distributed over the surface of the sealed section of filter paper.
5. Compressed gas is introduced to the top chamber through control valve 407, whereby the gas pressure and flow controllers 405/6 control and indirectly establish the filtration characteristics of the suspension by measuring the volumetric flow of gas in the top container 5. A sample of filtrate flows through a turbidity meter 410 to record the degree of clarity of the filtrate.

.....
The computer 15 chooses the filtration mode and type of medium:

Mode: precoat with medium speed diatomite with 1% body-feed

Medium: 20 micron polyestermonofil section of belt
.....

6. The depending rim portions (3) are raised and the filter paper is discharged.
7. The 20 micron belt section is automatically positioned in the container 1.
8. Steps 3,4,5 are repeated with a liquid of known filtration characteristics.
- 9a. Result of permeability test: negative. The section of belt is subjected to a standard cleaning/regeneration procedure after which steps 3,4,5 are repeated.
- 9b. Result: positive. With the container 1 vented, approx. 20l/m² of diatomite suspension are introduced to the top container 5.
10. While the chamber 5 is being pressurized with gas, suspension to be filtered with 1% diatomite body-feed is introduced under pressure through valve 407. The feed rate is controlled by a pressure differential controller 405. Filtration proceeds.
11. On reaching a preset pressure differential, filtration terminates. Valve 401 shuts.
12. Valve 407 opens. Gas forces rest suspension through the filter cake.
13. Gas flow controller 406 signals a break-through of gas through the filter cake.
14. Valve 407 shuts.
15. The valve 408 opens. A pre-set quantity of wash liquid is fed to the container 5.
16. Valve 408 shuts. Valve 407 opens. Gas forces wash liquid through the cake.
17. The flow controller 406 signals a break-through of gas through the filter cake.

18. Cake drying.
19. The valve 407 shuts. Container is vented by opening 411. Container opens.
20. Belt transport. Cake discharge.
21. Belt wash (belt wash liquid is used for subsequent cake wash operation).
- 22 20 micron belt section relocated in the container 1.

-cycle repeated-

Fig.5 & 6 show a schematic representation of an innovative filtrate chamber 2 whereby the the fixed pervious bed of the prior art is replaced by manually removable pervious elements 502 to facilitate the cleaning and/or sterilization of the internal surfaces and drainage members 504. According to the invention only planar, smooth surfaces of the floor of the filtrate chamber remain after the manual removal of the elements. In a preferred design, the filtrate chamber consists of a hollowed-out plate 505 with smooth polished upper surfaces on which the removable elements, preferably consisting of expanded sheets or layers of woven mesh of metal or plastics that are covered and integral with flat perforated sheet, mesh or profiled grid material. To accommodate the high liquid throughputs of the invention and to minimize the bulk and cost of the elements, generously proportioned multiple filtrate outlet conduits 506 are provided, preferably coinciding with the intervals of the fluid driven cylinders 215, whereby the conduits are made integral with the supporting framework and designed to support the filtrate chamber as well as to withstand the thrust of the closure of the upper container. These conduits are also designed for ease of access and cleaning.

Fig.7 shows a schematic drawing, wherein the filter web takes the form of a belt that is driven by a motor or actuator 702 to reverse the direction of transport of the belt to enable the discharge of the filter bed or filter cake at either end of the purifying apparatus 1. One of the major advantages of this configuration is that the permanent attachment of a bed regenerator 6 and a filter cake receiver at either end can be achieved.

The above described invention effectively bridges the gap between prior art sand (in-depth) and pressure filters presently employed in the liquid processing industries.

The implications are that both liquid processing and using industries can be rationalized and improved to increase their competitiveness and simultaneously reduce considerably the present negative impact on the environment.

CLAIMS

1. A liquid filtering apparatus consisting of a container with an internal lower horizontal, pervious base supporting a bed of loose, granular filter media; whereby the base has the form of a filtrate drainage member or chamber fitted with an outlet nozzle for filtrate and a inlet nozzle for backwash fluids and whereby the upper part of the container has an inlet connection for contaminated liquid at or above atmospheric pressure and an outlet connection for backwash fluids, *thereby characterized*, that the container (1) is divided horizontally at the level of the pervious horizontal base (2), whereby the dependent rim portions (3) of the top section of the container (5) are movable in the vertical direction to facilitate the removal of the bed from the container and whereby the container (5) is fitted with an inlet connection for contaminated liquid and the base (2) is fitted with an outlet nozzle for filtrate.

2. A liquid purifying apparatus according to Claim 1, *thereby characterized*, that a section of movable web of filter medium (4) is interposed between the pervious, horizontal support base (2) and the vertically movable dependent rim portions of the top section of the container (5), thus sealing a section(s) of the web at the periphery in the closed position, whereby in the raised position the filter bed after the purification operation is transported out of the container 1.

3. A liquid purifying apparatus according to claims 1 and 2, *thereby characterized*, that taken alone or in combination,

the bed after the purification operation is discharged into a bed regeneration device (6), whereby the bed material is regenerated and/or cleaned and recycled to the top container (5) of the filter for reuse;

the bed after the purification operation is discharged into a bed regeneration device 6, whereby the material of the bed is regenerated and/or cleaned and reactivated after which and before the purification operation, the bed is recycled to the top container (5) of the purifying apparatus (1) for reuse;

the bed material, after regeneration and/or cleaning and reactivation, is first recycled to a dosing device (7/20) that before the purification operation feeds the entire bed to the top container (5) of the purifying apparatus (1);

the bed after the purification operation is discharged into a bed regeneration device (6), whence, after regeneration and/or cleaning and reactivation, the bed material is then recycled by a dosing device (7/20) during the course of the purification operation to the filter container (5), whereby the depth of the bed increases incrementally during the course of the purification operation;

a conically perforated distributor (27) extends over the entire internal upper section of the container (5).

4. A liquid purifying apparatus and method according to Claims 1 and 2, *thereby characterized*, that taken alone or in combination,

the bed after the purification operation is discharged into a bed regeneration device (6), whence after regeneration and/or cleaning and activation of the surfaces of the material comprising the bed and before or after being fed to the filter container (5) in advance of the purification operation, the bed material is mixed with a suspension of active material such as bleaching earth, ion-exchange resin, activated carbon, etc., which if necessary has been pretreated with a surface activating medium to enhance its adhesion to the surface of the material comprising the bed;

the bed after the purification operation is discharged into a bed regeneration device (6), whence, after regeneration and/or cleaning and activation of the internal and external surfaces of the material comprising the bed, it is mixed with active material such as bleaching earth, activated carbon, etc. which is preferably pretreated with a surface activating medium to promote adhesion to the surface of the material comprising the bed and is dosed by a dosing device (7/20) to the feed of liquid to be purified from a reservoir (10) and thereby mixed in a mixing device (27) with the said feed either before or after entry into the filter container (5) during the purification operation or alternatively, the said material comprising the bed and the said active material are dosed separately by devices (7/20) and (8/19) respectively and mixed before or after being dosed to the liquid to be purified from reservoir 10 with which they are also mixed either before or after entry into the filter container (5).

5. A liquid purifying apparatus according to Claim 3 and 4, *thereby characterized*, that the dosing devices (7/20) and (8/19) are controlled by a microprocessor (15) from input signals from feed and filtrate instrumentation (13, 14).
6. A liquid purifying apparatus and method according to Clause 1 and 2, *thereby*

characterized, that taken individually or in combination, the filter web takes the form of an endless belt consisting of a plurality of sections (201, 202, 203) providing different degrees of filtrate quality or consisting of different materials;

the filter web takes the form of an endless belt consisting of a plurality of sections, whereby means (204, 205, 206) are provided for individually removing and replacing each section and automatically locating each section on the pervious, horizontal support base (2) by means of one or more electronic sensors (218) fixed to the frame of the apparatus and one or more electronically sensitive inserts (219) in the edges of the belt.

the filter web takes the form of a filter belt, whereby sections of it are used as support and transport means for introducing strips of pre-fabricated filter material from storage rolls located externally to the purification apparatus 1, whereby the strips are fed onto the filter belt by means of a belt-driven roller combination (207) and whereby after a set length of filter material has been fed onto the porous base (2) the strip is cut to size by the slitting device (208), after which the dependent rim portions of the container (5) are lowered onto the strip of filter material and the section of support belt against the pervious, horizontal support base 2;

the filter web takes the form of a filter belt, whereby sections of it are used as support and transport means for introducing strips of pre-fabricated portions of filter material from storage cassettes (225) located externally to the purification apparatus 1 from where single strips of filter medium (211, 212) are mechanically fed by the feeding mechanism (214, 213) and belt-driven roller combination (207) onto the pervious filtrate base (2) after which the dependent rim portions (3) are lowered to seal the strip of filter material and section of support belt against the pervious, horizontal support base (2);

the filter web takes the form of a filter belt, whereby sections of it, sealed by dependent rim portions 3, are used as support for dosed layers of suspension of filter aid fibres such as cellulose, glass, asbestos, etc. or powders such as diatomaceous earth, perlite, molecular sieves, etc. from an external dosing means (11), after which the pressure difference between the container (5) and the filtrate chamber (2) is increased with the introduction to the container (5) of liquid to be purified from a reservoir (10) and optionally a dosed quantity of a suspension of adsorbent or filter bed material from dosing means (7), whereby the formed layer of filter aid acts as either the primary filter medium or as a support and polishing or security layer for removing any particulate or dissolved matter escaping from the formed or forming bed:

means are provided for moving the dependent rim portions of the container (5) vertically, consisting of laterally positioned fluid driven pistons (304) contained in cylinders (215), the bodies of which are fixed to a load-bearing framework (306) with the external extremity of the lubricated shafts (307) connected to sectioned concentric cylindrical sleeves (301) extending and fixed to the extremities of transverse beams (308) that in turn actuate thrust shafts (303) acting on the peripheral part of the upper container (5), whereby to ensure the movement of the dependent rim portions in the horizontal position, ring sections of a suitable material such as polytetrafluorethylene (302) are fixed to the surfaces of the bodies of the fluid driven cylinders (215) and fitted in the annular space between the cylinder surfaces and the internal surfaces of the reciprocating sleeves (301);

the filter web takes the form of a filter belt, whereby the pervious horizontal base (2)) supporting a section of the belt consists of a recessed plate (505) containing a plurality of manually removable, belt supporting, filtrate drainage members (502) preferably made up of upper perforated sheet material (503) integrated with a lower layer or layers of such materials as woven mesh or expanded sheet material (504), whereby the upper perforated sheet material lies flush with the peripheral sealing portions of the plate (505);

the filter web takes the form of a filter belt, whereby the means in the form of a suitable motor or actuator (702) is provided to reverse the direction of the transport of the belt to discharge the filter bed at either end of the purifying apparatus (1).

7. A liquid purification apparatus and method according to Claim 6, *thereby characterized*, that taken individually or in combination,

means in the form of a gas pressure differential controller (405), a gas flow controller (406) and a gas flow control valve (407) provided in a compressed gas conduit (403) leading into the upper portion of the filter container (5) to control and record the volumetric gas flow into the said container and thereby provide a measure of the rate of filtration of a layer of liquid with unknown filtration characteristics lying on a section of sealed filter medium supported by a horizontal pervious support base (2);

means in the form of a programmed microprocessor (15) that receives data from instrumentation such as (405, 406) and/or (13) and/or (14) regarding the filtration characteristics and quality of a liquid processed by the purifying apparatus (1) and chooses and positions the type or types of media and mode of purification and/or

filtration to achieve a manually chosen menu of results;

means in the form of a programmed microprocessor (15) that receives data from instrumentation such as (405, 406) and/or (13) and/or (14) regarding the filtration characteristics of any given section of medium sealed within the purifying apparatus (1) and if necessary automatically initiates a medium regeneration and/or a renewal operation;

means in the form of a gas pressure differential controller (405), a gas flow controller (406) and a gas flow control valve (407) provided in a compressed gas conduit (403) leading into the upper portion of the container (5) to control and record the volumetric gas flow into the said container and thereby provide a measure of the rate of filtration of a layer of liquid with known filtration characteristics lying on a section of sealed filter medium with unknown filtration characteristics supported by a horizontal pervious support base (2);

means in the form of a programmed microprocessor (15) that receives data from instrumentation such as (405, 406) and/or (13) and/or (14) regarding the filtration characteristics and quality of a liquid processed by the purification apparatus (1) and chooses and positions the type or types of media and mode of purification and/or filtration to achieve a manually chosen menu of results;

means in the form of a programmed microprocessor (15) that receives data from instrumentation such as (405, 406) and/or (13) and/or (14) regarding the filtration characteristics of any given section of medium sealed by the container (5) and if necessary automatically either initiates a regeneration and/or renewal operation.

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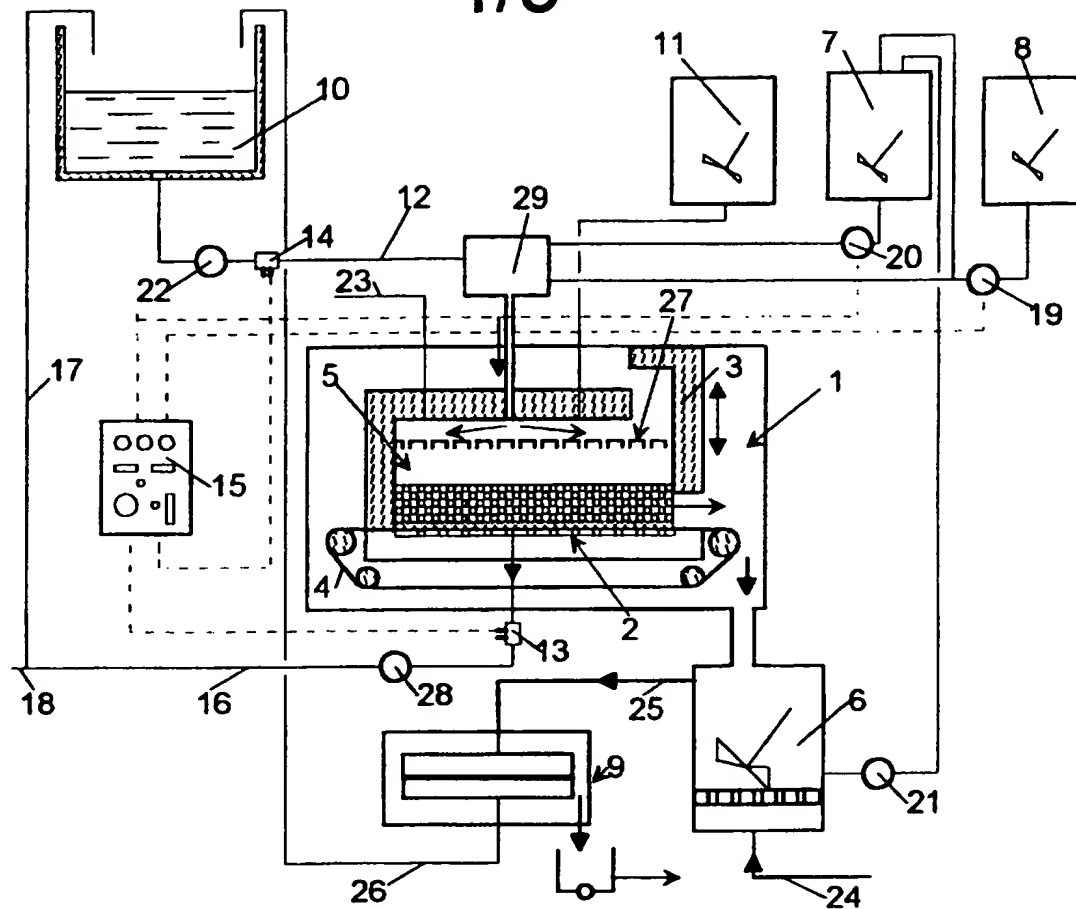


Fig. 1

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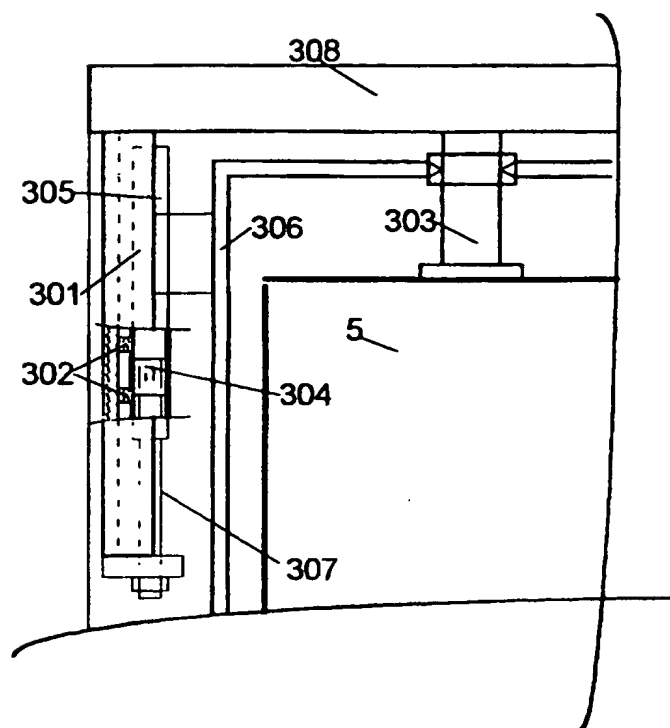


Fig.3

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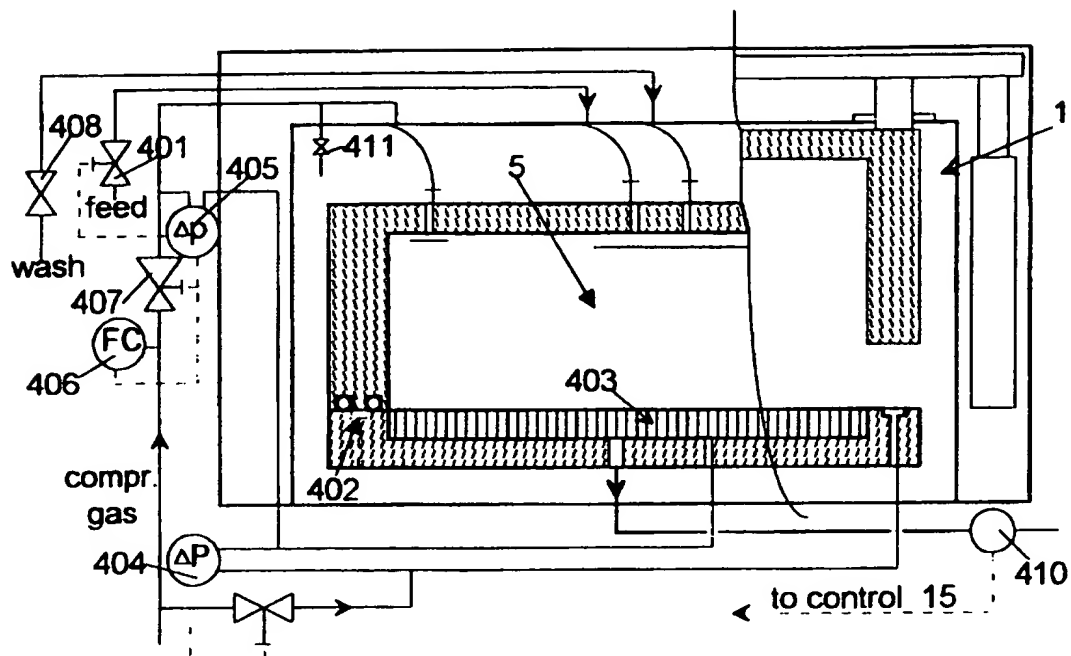


Fig.4

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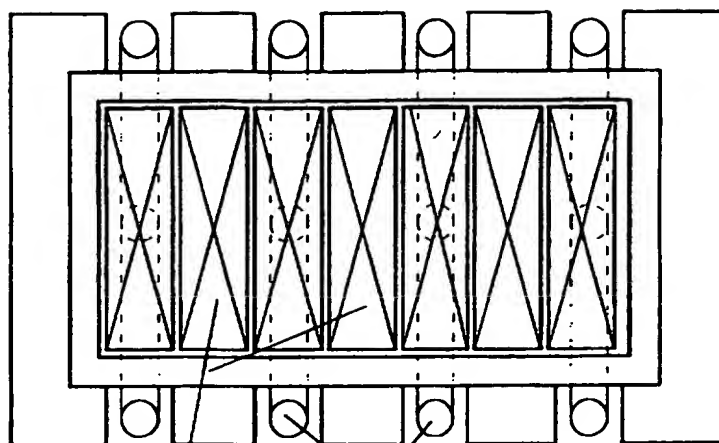


Fig.5

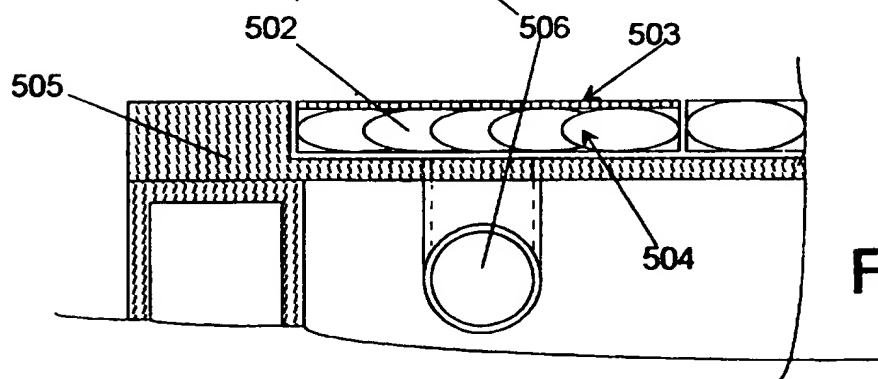


Fig.6

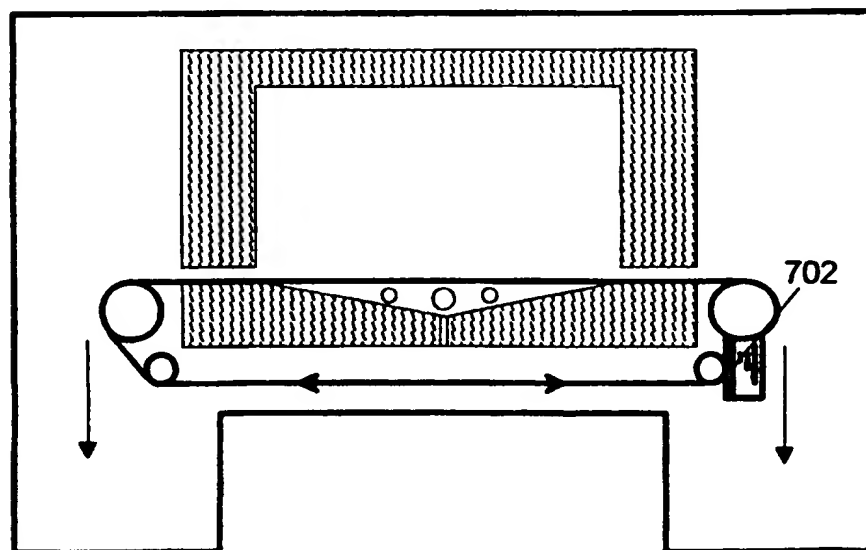
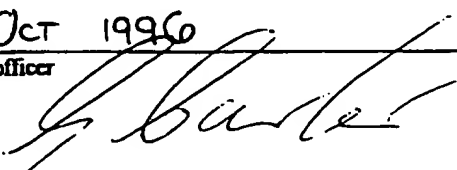


Fig.7

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/AU 96/00442

A. CLASSIFICATION OF SUBJECT MATTER		
Int Cl ⁶ : B01D 24/46, 29/96 41/02		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) IPC B01D 24/46 29/96 41/02		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched AU : IPC as above		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB A 876722 (HIRS) 12 December 1958	1-7
X	GB A 1058530 (HIRS) 15 February 1967	1-7
<input type="checkbox"/> Further documents are listed in the continuation of Box C <input type="checkbox"/> See patent family annex		
<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>* Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 45%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>"&" document member of the same patent family</p> </div> </div>		
Date of the actual completion of the international search 22 October 1996		Date of mailing of the international search report 30 Oct 1996
Name and mailing address of the ISA/AU AUSTRALIAN INDUSTRIAL PROPERTY ORGANISATION PO BOX 200 WODEN ACT 2606 AUSTRALIA Facsimile No.: (06) 285 3929		Authorized officer  G. Carter Telephone No.: (06) 283 2154

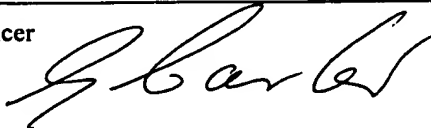
REC'D 05 FEB 1999

WIPO PCT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference Miller	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416).
International application No. PCT/AU 96/00442	International filing date (day/month/year) 5 August 1996	Priority Date (day/month/year) 5 August 1996
International Patent Classification (IPC) or national classification and IPC Int. Cl. ⁶ B01D 24/46, 29/96, 41/02		
Applicant MILLER, Peter Anthony		

1.	This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.																
2.	This REPORT consists of a total of 4 sheets, including this cover sheet. <input checked="" type="checkbox"/> This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT). These annexes consist of a total of 6 sheet(s).																
3.	This report contains indications relating to the following items: <table border="0"> <tr> <td>I</td> <td><input checked="" type="checkbox"/> Basis of the report</td> </tr> <tr> <td>II</td> <td><input type="checkbox"/> Priority</td> </tr> <tr> <td>III</td> <td><input type="checkbox"/> Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</td> </tr> <tr> <td>IV</td> <td><input checked="" type="checkbox"/> Lack of unity of invention</td> </tr> <tr> <td>V</td> <td><input checked="" type="checkbox"/> Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</td> </tr> <tr> <td>VI</td> <td><input type="checkbox"/> Certain documents cited</td> </tr> <tr> <td>VII</td> <td><input type="checkbox"/> Certain defects in the international application</td> </tr> <tr> <td>VIII</td> <td><input type="checkbox"/> Certain observations on the international application</td> </tr> </table>	I	<input checked="" type="checkbox"/> Basis of the report	II	<input type="checkbox"/> Priority	III	<input type="checkbox"/> Non-establishment of opinion with regard to novelty, inventive step and industrial applicability	IV	<input checked="" type="checkbox"/> Lack of unity of invention	V	<input checked="" type="checkbox"/> Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement	VI	<input type="checkbox"/> Certain documents cited	VII	<input type="checkbox"/> Certain defects in the international application	VIII	<input type="checkbox"/> Certain observations on the international application
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VI	<input type="checkbox"/> Certain documents cited																
VII	<input type="checkbox"/> Certain defects in the international application																
VIII	<input type="checkbox"/> Certain observations on the international application																

Date of submission of the demand 27 February 1998	Date of completion of the report 27 January 1999
Name and mailing address of the IPEA/AU AUSTRALIAN PATENT OFFICE PO BOX 200 WODEN ACT 2606 AUSTRALIA Facsimile No. (02) 6285 3929	Authorized Officer  G. CARTER Telephone No. (02) 6283 2154

IV. Lack of unity of invention

1. In response to the invitation to restrict or pay additional fees the applicant has:

- ☐ restricted the claims.
- ☐ paid additional fees.
- ☐ paid additional fees under protest.
- ☐ neither restricted nor paid additional fees.

2. ☒ This Authority found that the requirement of unity of invention is not complied with and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is

- ☐ complied with.
- ☒ not complied with for the following reasons:

Claims 1-9 relate to a filter with a deep static bed of granular material (such as sand) acting as filter material in a container which is divided in such a way that a dependent rim portion of the upper chamber is movable to facilitate the discharge of the bed from the container.

Claims 10-20 relate to a filter with a section of web of filter material and a cover means with movable dependent rim sections sealingly engaging the web in which the web consists of a band with a plurality of sections providing different degrees of filtrate quality.

4. Consequently, the following parts of the international application were the subject of international preliminary examination in establishing this report:

- ☒ all parts.
- ☐ the parts relating to claims Nos.

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**1. Statement**

Novelty (N)	Claims 1-20	YES
	Claims	NO
Inventive step (IS)	Claims 1-20	YES
	Claims	NO
Industrial applicability (IA)	Claims 1-20	YES
	Claims	NO

2. Citations and explanations (Rule 70.7)

None of the citations disclose a filter with a deep static bed of granular material (such as sand) acting as a filter medium in a container which is divided in such a way that a dependent rim portion of the upper chamber is movable to facilitate discharge of the bed from the container or a filter with all the features of claim 10 including a band consisting of a plurality of sections providing different degrees of filtrate quality.

I. Basis of the report**1. With regard to the elements of the international application:***

- ☐ the international application as originally filed.
- ☒ the description, pages 1, 3-6, as originally filed,
pages , filed with the demand,
pages 2, filed with the letter of 19 January 1999.
- ☒ the claims, pages , as originally filed,
pages , as amended (together with any statement) under Article 19,
pages , filed with the demand,
pages 7-11, filed with the letter of 13 January 1999.
- ☒ the drawings, sheets 1-5, as originally filed,
pages , filed with the demand,
pages , filed with the letter of .
- ☐ the sequence listing part of the description:
pages , as originally filed
pages , filed with the demand
pages , filed with the letter of

2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language which is:

- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, was on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

4. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages
- ☐ the claims, Nos.
- ☐ the drawings, sheets/fig

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

** Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report

above named industries, whereby the beds are regenerated and reused more effectively than with prior art methods, resulting in a considerable reduction in the quantity of liquid and solid waste for disposal. Considering the present practice, in both the industrial and communal sector, of discharging effluent to the natural environment that is incompletely purified, the further goal is to provide these sectors with an effluent and water purification apparatus that will enable liquid effluent to be recycled and polluted water to be rendered suitable for domestic and industrial purposes.

It is proposed that the apparatus of the invention will be far more compact and versatile compared with the prior art in that it can be installed not only in large industrial and communal plants, but also in the medium to small size industrial sector. This will be achieved by utilizing specific through-puts 10-100 times those normally employed by prior art filters. Specific through-puts of 50-200 m³/m².h will be possible because the beds will be maintained in an "open" condition throughout the filtration and/or purification cycles. A further goal of the invention is to provide the liquid purification apparatus of the invention with the means for automatically selecting and applying varying types and grades of filter media and modes of operation according to the nature, filtration characteristics and requirements of any type of liquid purification operation, whereby no further distinction will be made between effluent, water and process liquid purification. The ultimate aim of the invention is to reduce the number of purification steps presently required for process liquid purification, whereby waste generation will be reduced and the purification media regenerated and reused, thus enhancing the competitiveness of these industries and simultaneously relieving the present impact on the environment. The aim of the invention with industries presently using liquids in their production processes for such operations as plating, dyeing, washing, coating, pickling, quenching, etc. is to provide the means for continuous regeneration to avoid the necessity for dumping into the environment.

THE INVENTION

Fig.1 is a schematic flow-sheet of the apparatus of the invention that consists of a purifying filter plant 1, comprising essentially a lower stationary filtrate chamber 2 with a porous upper surface on which a section of an intermittently movable filter belt 4 is supported which in operation is stationary and sealed at the periphery by vertically movable dependent rim portions 3 of an upper contaminant container 5 fitted with a conically perforated feed distributor 27 extending over the entire upper horizontal section, a bed regeneration apparatus 6, a bed material storage/dosing vessel 7, a filter aid suspension tank 11, one or more adsorbent storage/dosing devices 8, a reservoir for liquid to be purified 10 and a residue filter 9.

Filter aid suspended in liquid in tank 11 is dosed into the vented container 5. While the pressure difference between the container 5 and the lower filtrate chamber 2 is raised, liquid to be purified in reservoir 10, which may be dosed with flocculating

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Claims

1. Liquid filtering apparatus in the form of an open or closed vessel containing deep, static beds of coarse granular material such as sand acting as filter medium supported on a porous floor that divides the vessel into an upper turbid liquid chamber with an inlet nozzle or connection and an upper outlet or connection for the removal of bed backwashing liquid and a lower filtrate chamber with a backwashing liquid inlet nozzle and a filtrate outlet nozzle, whereby in operation to remove suspended solids the turbid liquid is preferably passed from top to bottom through the bed after which, and before repeating the cycle, clean liquid such as filtrate is passed through the bed from bottom to top to remove the solids trapped in the bed which leave the container as a suspension through a top outlet nozzle or connection, *thereby characterized*, that the container (1) with an upper turbid liquid feed conduit (12) and a lower filtrate outlet conduit (16) is divided in the vicinity of the level of the pervious horizontal base (2) in such a way that a dependent rim portion(s) (3) of the upper turbid liquid chamber (5) is movable to facilitate the discharge of the bed from the container.

2. Liquid filtering apparatus according to Claim 1, *thereby characterized*, that means are provided to discharge the bed to a bed regeneration device (6), where the bed material is cleaned or cleaned and reactivated and recycled to the turbid liquid chamber (5) of the filtering apparatus (1) for reuse.

3. Liquid filtering apparatus according to Claim 1, *thereby characterized*, that means are provided to discharge the bed to a bed regeneration device (6), where the material of the bed is cleaned or cleaned and reactivated and thence recycled to a dosing device (7/20) and thence to the turbid liquid chamber (5) of the filtering apparatus (1) for reuse.

4. Liquid filtering apparatus according to Claim 1, *thereby characterized*, that means are provided to discharge the bed to a bed regeneration device (6), where the material of the bed is cleaned or cleaned and reactivated and thence recycled to the dosing device (7/20) and thence dosed to the turbid liquid chamber (5) of the filtering apparatus (1) during the filtration operation, whereby the depth of the bed increases incrementally during the operation.

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5. Liquid purifying apparatus and method according to Claims 1-4, *thereby characterized*, that the cleaned or cleaned and reactivated bed before being recycled to the turbid liquid chamber (5) for reuse is mixed with active powdered material such as bleaching earth, ion-exchange resins, activated carbon, etc.
6. Liquid purifying apparatus and method according to Claim 5, *thereby characterized*, that a dosing apparatus (8/19) is employed to dose the active powdered material to the granular material of the bed either before or during the purification operation when the depth of the bed increases incrementally.
7. Liquid filtering and purifying method according to Claims 5, 6, *thereby characterized*, that means are provided to treat the surface of the powdered active material with a surface activating medium to enhance its adhesion to the activated surface of the granular material comprising the bed.
8. Liquid filtering and purifying method according to Claims 1-7, *thereby characterized*, that the liquid to be filtered and/or purified in reservoir (10) is dosed with flocculating substances such as polyelectrolytes before or during the filtration and purifying operation.
9. Liquid filtering apparatus according to Claim 1, *thereby characterized*, that means are provided in the form of a conically perforated distributor (27) that extends over the entire internal cross-section of the turbid liquid chamber (5).
10. Liquid filtering apparatus consisting of
- a section of web of filter medium lying on and supported by a porous support surface;
 - cover means with dependent rim section(s) extending downwards, the lower surfaces of which make direct sealing engagement with peripheral portions of the said section of web of filter medium, thus forming an upper turbid liquid chamber;
 - a receptacle for filtered liquid located beneath the porous support surface having upstanding rim portions, the upper surfaces of which make sealing engagement with the lower peripheral portions of the section of web of filter medium forming a lower filtrate chamber;

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- means for engaging and disengaging the said lower and upper and surfaces of the said upper cover and lower receptacle, thus sealing and releasing respectively the said portions of the filter web;
- conduit means in fluid communication with a source of turbid liquid *and* gas and the interior of the cover means;
- conduit means for removing filtrate from the receptacle for filtered liquid;
- means for interrupting or initiating the flow of liquid or gas in the said conduits;
- means to control the filtration operation consisting of a throttling valve located in the said turbid liquid conduit controlled by a device measuring the differential pressure between the turbid liquid chamber and the receptacle for filtered liquid, as well as means in the form of a gas flow controller, a gas throttling valve and a gas pressure controller in series in the said gas conduit controlling the throughput of filtrate to the receptacle for filtered liquid;
- means to transport filter residue consisting of a web of filter medium in the form of a band,
whereby the band consists of a plurality of sections (201/2/3) providing different degrees of filtrate quality or consisting of different materials;

11. Liquid filtering apparatus according to Claim 10, *whereby* the band consisting of a plurality of sections is provided with the means (204/5/6) for individually removing and replacing each section.

12. Liquid filtering apparatus according to Claim 10, *whereby* sections of the band are used as support for strips of prefabricated filter media from storage means either pre-cut or cut "in-situ" to appropriate length and then introduced to the interior of the turbid liquid chamber (5) to coincide with the pervious horizontal base (2) and sealed at the periphery (402) by the dependent rim portion(s) (3) of the said chamber.

13. Method of liquid purification according to Claim 1, *thereby characterized*, that as support for the bed of granular material a layer of finely powdered filter aid is first of all formed on the section of filter medium in the turbid liquid chamber (5).

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14. Liquid purifying apparatus according to Claims 4/6, *thereby characterized*, that the dosing devices are controlled by a microprocessor (15) from input signals from feed and filtrate instrumentation (13,14).

15. Apparatus and method of filtration control according to the defining preamble of Claim 10, *whereby* means to control the filtration operation consist of a gas flow controller, a gas throttling valve and a gas pressure controller connected in series from a source of compressed gas to the turbid liquid chamber (5) , *thereby characterized*, that the said means are employed to measure the *permeability* of any filter media before or during any liquid filtration or purification operation by introducing and filtering a volume of liquid of *known* quality to the turbid liquid chamber.

16. Apparatus and method of liquid purification control according to Claim 15, *thereby characterized*, that the *quality* of the turbid liquid and filtrate are determined by instrumentation such as (13/14), whereby optionally the data is fed to a microprocessor/process controller (15) to choose and implement the supply of the optional filter medium before or during any liquid purification operation.

17. Apparatus and method of liquid purification control according to Claims 11 - 16, *thereby characterized*, that the optimal *mode* of purification such as direct filtration by textiles, membranes, non-woven material, precoat filtration, deep-bed purification with or without active powdered material, etc. is determined before or during any liquid purification operation.

18. Apparatus according to the defining preamble of Claim 10, *whereby* the means for engaging and disengaging the upper and lower surfaces of the upper cover and lower receptacle consist of laterally positioned fluid driven pistons (304) contained in cylinders (305), the bodies of which are fixed to a load-bearing framework with the

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external extremity of the lubricated shafts (307) connected to sectioned sleeves (301) extending and fixed to the extremities of transverse beams (308) acting on the peripheral part of the upper container (5), *whereby* to ensure movement of the dependent rim portion(s) in the horizontal position, sections of material such as polytetrafluorethylene (302) are fixed to the surfaces of the bodies of the fluid driven cylinders (305) fitted in the space between the cylinder surfaces and the internal surfaces of the reciprocating sleeves (301).

19. Apparatus according to the defining preamble of Claim 10, *whereby* the receptacle for filtered liquid located beneath the porous support surface consists of a recessed plate (505) containing one or a plurality of manually removable medium supporting drainage members (502) preferably consisting of an upper perforated sheet (503) lying flush with the peripheral sealing portions of the plate (505) and integrated with a lower layer or layers of material such as woven mesh or expanded metal sheet (504).

20. Apparatus according to the defining preamble of Claim 10, *whereby* the means for transporting the filter residue in the form of a band is driven by a motor or actuator (702) provided with the facility for reversing the direction of transport of the band to discharge the filter bed or residue at either end of the purifying apparatus.

above named industries, whereby the beds are regenerated and reused more effectively than with prior art methods, resulting in a considerable reduction in the quantity of liquid and solid waste for disposal. Considering the present practice, in both the industrial and communal sector, of discharging effluent to the natural environment that is incompletely purified, the further goal is to provide these sectors with an effluent and water purification apparatus that will enable liquid effluent to be recycled and polluted water to be rendered suitable for domestic and industrial purposes.

It is proposed that the apparatus of the invention will be far more compact and versatile compared with the prior art in that it can be installed not only in large industrial and communal plants, but also in the medium to small size industrial sector. This will be achieved by utilizing specific through-puts 10-100 times those normally employed by prior art filters. Specific through-puts of 50-200 m³/m².h will be possible because the beds will be maintained in an "open" condition throughout the filtration and/or purification cycles. A further goal of the invention is to provide the liquid purification apparatus of the invention with the means for automatically selecting and applying varying types and grades of filter media and modes of operation according to the nature, filtration characteristics and requirements of any type of liquid purification operation, whereby no further distinction will be made between effluent, water and process liquid purification. The ultimate aim of the invention is to reduce the number of purification steps presently required for process liquid purification, whereby waste generation will be reduced and the purification media regenerated and reused, thus enhancing the competitiveness of these industries and simultaneously relieving the present impact on the environment. The aim of the invention with industries presently using liquids in their production processes for such operations as plating, dyeing, washing, coating, pickling, quenching, etc. is to provide the means for continuous regeneration to avoid the necessity for dumping into the environment.

THE INVENTION

Fig.1 is a schematic flow-sheet of the apparatus of the invention that consists of a purifying filter plant 1, comprising essentially a lower stationary filtrate chamber 2 with a porous upper surface on which a section of an intermittently movable filter belt 4 is supported which in operation is stationary and sealed at the periphery by vertically movable dependent rim portions 3 of an upper contaminant container 5 fitted with a conically perforated feed distributor 27 extending over the entire upper horizontal section, a bed regeneration apparatus 6, a bed material storage/dosing vessel 7, a filter aid suspension tank 11, one or more adsorbent storage/dosing devices 8, a reservoir for liquid to be purified 10 and a residue filter 9.

Filter aid suspended in liquid in tank 11 is dosed into the vented container 5. While the pressure difference between the container 5 and the lower filtrate chamber 2 is raised, liquid to be purified in reservoir 10, which may be dosed with flocculating

CLAIMS

1. A liquid filtering apparatus consisting of a container with an internal lower horizontal, pervious base supporting a bed of loose, granular filter media;
whereby the base has the form of a filtrate drainage member or chamber fitted with an outlet nozzle for filtrate and a inlet nozzle for backwash fluids
and whereby the upper part of the container has an inlet connection for contaminated liquid at or above atmospheric pressure and an outlet connection for backwash fluids,
thereby characterized,
that the container (1) is divided horizontally at the level of the pervious horizontal base (2), whereby the dependent rim portions (3) of the top section of the container (5) are movable in the vertical direction to facilitate the removal of the bed from the container and whereby the container (5) is fitted with an inlet connection for contaminated liquid and the base (2) is fitted with an outlet nozzle for filtrate.
2. A liquid purifying apparatus according to Claim 1, *thereby characterized,* that a section of movable web of filter medium (4) is interposed between the pervious, horizontal support base (2) and the vertically movable dependent rim portions of the top section of the container (5), thus sealing a section(s) of the web at the periphery in the closed position, whereby in the raised position the filter bed after the purification operation is transported out of the container 1.
3. A liquid purifying apparatus according to claims 1 and 2, *thereby characterized,* that taken alone or in combination,

the bed after the purification operation is discharged into a bed regeneration device (6), whereby the bed material is regenerated and/or cleaned and recycled to the top container (5) of the filter for reuse;

the bed after the purification operation is discharged into a bed regeneration device(6), whereby the material of the bed is regenerated and/or cleaned and reactivated after which and before the purification operation, the bed is recycled to the top container (5) of the purifying apparatus (1) for reuse;

the bed material, after regeneration and/or cleaning and reactivation, is first recycled to a dosing device (7/20) that before the purification operation feeds the entire bed to the top container (5) of the purifying apparatus (1);

characterized, that taken individually or in combination, the filter web takes the form of an endless belt consisting of a plurality of sections (201, 202, 203) providing different degrees of filtrate quality or consisting of different materials;

the filter web takes the form of an endless belt consisting of a plurality of sections, whereby means (204, 205, 206) are provided for individually removing and replacing each section and automatically locating each section on the pervious, horizontal support base (2) by means of one or more electronic sensors (218) fixed to the frame of the apparatus and one or more electronically sensitive inserts (219) in the edges of the belt.

the filter web takes the form of a filter belt, whereby sections of it are used as support and transport means for introducing strips of pre-fabricated filter material from storage rolls located externally to the purification apparatus 1, whereby the strips are fed onto the filter belt by means of a belt-driven roller combination (207) and whereby after a set length of filter material has been fed onto the porous base (2) the strip is cut to size by the slitting device (208), after which the dependent rim portions of the container (5) are lowered onto the strip of filter material and the section of support belt against the pervious, horizontal support base 2;

the filter web takes the form of a filter belt, whereby sections of it are used as support and transport means for introducing strips of pre-fabricated portions of filter material from storage cassettes (226) located externally to the purification apparatus 1 from where single strips of filter medium (211, 212) are mechanically fed by the feeding mechanism (214, 213) and belt-driven roller combination (207) onto the pervious filtrate base (2) after which the dependent rim portions (3) are lowered to seal the strip of filter material and section of support belt against the pervious, horizontal support base (2);

the filter web takes the form of a filter belt, whereby sections of it, sealed by dependent rim portions 3, are used as support for dosed layers of suspension of filter aid fibres such as cellulose, glass, asbestos, etc. or powders such as diatomaceous earth, perlite, molecular sieves, etc. from an external dosing means (11), after which the pressure difference between the container (5) and the filtrate chamber (2) is increased with the introduction to the container (5) of liquid to be purified from a reservoir (10) and optionally a dosed quantity of a suspension of adsorbent or filter bed material from dosing means (7), whereby the formed layer of filter aid acts as either the primary filter medium or as a support and polishing or security layer for removing any particulate or dissolved matter escaping from the formed or forming bed;

the bed after the purification operation is discharged into a bed regeneration device (6), whence, after regeneration and/or cleaning and reactivation, the bed material is then recycled by a dosing device (7/20) during the course of the purification operation to the filter container (5), whereby the depth of the bed increases incrementally during the course of the purification operation;

a conically perforated distributor (27) extends over the entire internal upper section of the container (5).

4. A liquid purifying apparatus and method according to Claims 1 and 2, *thereby characterized*, that taken alone or in combination,

the bed after the purification operation is discharged into a bed regeneration device (6), whence after regeneration and/or cleaning and activation of the surfaces of the material comprising the bed and before or after being fed to the filter container (5) in advance of the purification operation, the bed material is mixed with a suspension of active material such as bleaching earth, ion-exchange resin, activated carbon, etc., which if necessary has been pretreated with a surface activating medium to enhance its adhesion to the surface of the material comprising the bed;

the bed after the purification operation is discharged into a bed regeneration device (6). whence, after regeneration and/or cleaning and activation of the internal and external surfaces of the material comprising the bed, it is mixed with active material such as bleaching earth, activated carbon, etc. which is preferably pretreated with a surface activating medium to promote adhesion to the surface of the material comprising the bed and is dosed by a dosing device (7/20) to the feed of liquid to be purified from a reservoir (10) and thereby mixed in a mixing device (29) with the said feed either before or after entry into the filter container (5) during the purification operation or alternatively, the said material comprising the bed and the said active material are dosed separately by devices (7/20) and (8/19) respectively and mixed before or after being dosed to the liquid to be purified from reservoir 10 with which they are also mixed either before or after entry into the filter container (5).

5. A liquid purifying apparatus according to Claim 3 and 4, *thereby characterized*, that the dosing devices (7/20) and (8/19) are controlled by a microprocessor (15) from input signals from feed and filtrate instrumentation (13, 14).

6. A liquid purifying apparatus and method according to Clause 1 and 2, *thereby*

means are provided for moving the dependent rim portions of the container (5) vertically, consisting of laterally positioned fluid driven pistons (304) contained in cylinders (215), the bodies of which are fixed to a load-bearing framework (306) with the external extremity of the lubricated shafts (307) connected to sectioned concentric cylindrical sleeves (301) extending and fixed to the extremities of transverse beams (308) that in turn actuate thrust shafts (303) acting on the peripheral part of the upper container (5), whereby to ensure the movement of the dependent rim portions in the horizontal position, ring sections of a suitable material such as polytetrafluorethylene (302) are fixed to the surfaces of the bodies of the fluid driven cylinders (215) and fitted in the annular space between the cylinder surfaces and the internal surfaces of the reciprocating sleeves (301);

the filter web takes the form of a filter belt, whereby the pervious horizontal base (2) supporting a section of the belt consists of a recessed plate (505) containing a plurality of manually removable, belt supporting, filtrate drainage members (502) preferably made up of upper perforated sheet material (503) integrated with a lower layer or layers of such materials as woven mesh or expanded sheet material (504), whereby the upper perforated sheet material lies flush with the peripheral sealing portions of the plate (505);

the filter web takes the form of a filter belt, whereby the means in the form of a suitable motor or actuator (702) is provided to reverse the direction of the transport of the belt to discharge the filter bed at either end of the purifying apparatus (1).

7. A liquid purification apparatus and method according to Claim 6, *thereby characterized*, that taken individually or in combination,

means in the form of a gas pressure differential controller (405), a gas flow controller (406) and a gas flow control valve (407) provided in a compressed gas conduit (403) leading into the upper portion of the filter container (5) to control and record the volumetric gas flow into the said container and thereby provide a measure of the rate of filtration of a layer of liquid with unknown filtration characteristics lying on a section of sealed filter medium supported by a horizontal pervious support base (2);

means in the form of a programmed microprocessor (15) that receives data from instrumentation such as (405, 406) and/or (13) and/or (14) regarding the filtration characteristics and quality of a liquid processed by the purifying apparatus (1) and chooses and positions the type or types of media and mode of purification and/or

Phone: 07152 902234

Fax: 07152 902234

* amended claims 1-20

13.1.99

I P Australia
Discovery House
Phillip
ACT 2606

P. 7-11

For the attention of Peter Collier, Receiving Office

Re> PCT/AU 96/00442

Your communication dated 17.12.98 received 05.1.99

Message;

Reply to the **second** written opinion:

The main thrust of this **2nd** opinion of the International Preliminary Examining Authority centers around the contention that

- ✓ the applicant's original Claim 1 is not allowable as it is already disclosed in the applicant's own patent GB2280857;
- ✓ the applicant's amended Claim 1 is also not allowable since it goes beyond the disclosure in the application as filed;
- ✓ that precoat layers of powders such as diatomaceous earth fall well within the same category as "beds of granular material" and that therefore Claims 1 & 2 of the original claims lack novelty and inventive step.

Reply:

- In the patent "guide-line" catalogues of the major industrialised countries clear distinctions in the form of "**CLASSIFICATIONS**" are made wherein essentially differing technologies are separated for the purposes of patent examination. All forms of such classifications known to the applicant concerning liquid purification technologies involving "powders" such as diatomaceous earth, perlite, bleaching earth, etc. are clearly distinguished from "loose, granular materials" as completely separate technological areas. The contention that these technological areas fall "well within the same category" according to intellectual property rights is clearly unfounded.

- It is also unfounded from the practical point of view:
 “Sand” filtration has been for centuries and still is, according to the “state of the art” regarding water purification, world-wide the dominating technology - certainly close to 100% of the world’s “purified” water goes through some form of deep bed sand filter system. Not a single engineer active in this field would categorize the filter disclosed in the applicant’s patent GB 2280857 or any other “state of the art” precoat filter as serious contenders for improving the present “state of the art” water purification technology. The idea of the applicant to discharge the contents of the deep beds to an external location for regeneration and return it to the filter container for reuse is also not new. Patent literature contains many disclosures concerning ways and means to achieve this. However, it is significant that none has succeeded in practice and to the best of the applicant’s knowledge no previous disclosure discloses the possibility of physically separating the “state of the art” sand *containers* at or near the horizontal pervious bed support surface in such a way that the sand bed removal for regeneration is facilitated.
- The applicant has therefor amended the previous original Claims 1-5 to new Claims 1-9 in accordance with this fact. The idea is therefore novel, inventive and potentially of enormous industrial applicability. The remaining original Claims 6-7 have been amended to new Claims 10-20, whereby further innovations concerning the genre of filter disclosed in GB 2280857 to achieve the goal of the present application described in pages 1&2 of the original description have been achieved.
- The applicant’s first amended Claim 1 does not go beyond the disclosure in the application as filed:
 “a centralized apparatus as part of a system for the universal purification of diverse liquids in the liquid processing industries and the fields of water and effluent purification”.
 In the final paragraph, page 6 of the disclosure as filed stands:
 “The above invention effectively bridges the gap between prior art sand and pressure filters presently employed in the liquid processing industries”.
 In achieving this, according to the invention, a universally applicable liquid purification apparatus, systems and methods for the liquid processing and water and effluent treatment are a reality.
- Page 2 has been reprinted to correct typographical errors.

Peter Miller

Claims

1. Liquid filtering apparatus in the form of an open or closed vessel containing deep, static beds of coarse granular material such as sand acting as filter medium supported on a porous floor that divides the vessel into an upper turbid liquid chamber with an inlet nozzle or connection and an upper outlet or connection for the removal of bed backwashing liquid and a lower filtrate chamber with a backwashing liquid inlet nozzle and a filtrate outlet nozzle, whereby in operation to remove suspended solids the turbid liquid is preferably passed from top to bottom through the bed after which, and before repeating the cycle, clean liquid such as filtrate is passed through the bed from bottom to top to remove the solids trapped in the bed which leave the container as a suspension through a top outlet nozzle or connection, *thereby characterized*, that the container (1) with an upper turbid liquid feed conduit (12) and a lower filtrate outlet conduit (16) is divided in the vicinity of the level of the pervious horizontal base (2) in such a way that a dependent rim portion(s) (3) of the upper turbid liquid chamber (5) is movable to facilitate the discharge of the bed from the container.

2. Liquid filtering apparatus according to Claim 1, *thereby characterized*, that means are provided to discharge the bed to a bed regeneration device (6), where the bed material is cleaned or cleaned and reactivated and recycled to the turbid liquid chamber (5) of the filtering apparatus (1) for reuse.

3. Liquid filtering apparatus according to Claim 1, *thereby characterized*, that means are provided to discharge the bed to a bed regeneration device (6), where the material of the bed is cleaned or cleaned and reactivated and thence recycled to a dosing device (7/20) and thence to the turbid liquid chamber (5) of the filtering apparatus (1) for reuse.

4. Liquid filtering apparatus according to Claim 1, *thereby characterized*, that means are provided to discharge the bed to a bed regeneration device (6), where the material of the bed is cleaned or cleaned and reactivated and thence recycled to the dosing device (7/20) and thence dosed to the turbid liquid chamber (5) of the filtering apparatus (1) during the filtration operation, whereby the depth of the bed increases incrementally during the operation.

5. Liquid purifying apparatus and method according to Claims 1-4, *thereby characterized*, that the cleaned or cleaned and reactivated bed before being recycled to the turbid liquid chamber (5) for reuse is mixed with active powdered material such as bleaching earth, ion-exchange resins, activated carbon, etc.

6. Liquid purifying apparatus and method according to Claim 5, *thereby characterized*, that a dosing apparatus (8/19) is employed to dose the active powdered material to the granular material of the bed either before or during the purification operation when the depth of the bed increases incrementally.

7. Liquid filtering and purifying method according to Claims 5, 6, *thereby characterized*, that means are provided to treat the surface of the powdered active material with a surface activating medium to enhance its adhesion to the activated surface of the granular material comprising the bed.

8. Liquid filtering and purifying method according to Claims 1-7, *thereby characterized*, that the liquid to be filtered and/or purified in reservoir (10) is dosed with flocculating substances such as polyelectrolytes before or during the filtration and purifying operation.

9. Liquid filtering apparatus according to Claim 1, *thereby characterized*, that means are provided in the form of a conically perforated distributor (27) that extends over the entire internal cross-section of the turbid liquid chamber (5).

10. Liquid filtering apparatus consisting of

- a section of web of filter medium lying on and supported by a porous support surface;
 - cover means with dependent rim section(s) extending downwards, the lower surfaces of which make direct sealing engagement with peripheral portions of the said section of web of filter medium, thus forming an upper turbid liquid chamber;
 - a receptacle for filtered liquid located beneath the porous support surface having upstanding rim portions, the upper surfaces of which make sealing engagement with the lower peripheral portions of the section of web of filter medium forming a lower filtrate chamber;
-

- means for engaging and disengaging the said lower and upper and surfaces of the said upper cover and lower receptacle, thus sealing and releasing respectively the said portions of the filter web;
- conduit means in fluid communication with a source of turbid liquid *and* gas and the interior of the cover means;
- conduit means for removing filtrate from the receptacle for filtered liquid;
- means for interrupting or initiating the flow of liquid or gas in the said conduits;
- means to control the filtration operation consisting of a throttling valve located in the said turbid liquid conduit controlled by a device measuring the differential pressure between the turbid liquid chamber and the receptacle for filtered liquid, as well as means in the form of a gas flow controller, a gas throttling valve and a gas pressure controller in series in the said gas conduit controlling the throughput of filtrate to the receptacle for filtered liquid;
- means to transport filter residue consisting of a web of filter medium in the form of a band,
whereby the band consists of a plurality of sections (201/2/3) providing different degrees of filtrate quality or consisting of different materials;

11. Liquid filtering apparatus according to Claim 10, *whereby* the band consisting of a plurality of sections is provided with the means (204/5/6) for individually removing and replacing each section.

12. Liquid filtering apparatus according to Claim 10, *whereby* sections of the band are used as support for strips of prefabricated filter media from storage means either pre-cut or cut "in-situ" to appropriate length and then introduced to the interior of the turbid liquid chamber (5) to coincide with the pervious horizontal base (2) and sealed at the periphery (402) by the dependent rim portion(s) (3) of the said chamber.

13. Method of liquid purification according to Claim 1, *thereby characterized*, that as support for the bed of granular material a layer of finely powdered filter aid is first of all formed on the section of filter medium in the turbid liquid chamber (5).

14. Liquid purifying apparatus according to Claims 4/6, *thereby characterized*, that the dosing devices are controlled by a microprocessor (15) from input signals from feed and filtrate instrumentation (13,14).

15. Apparatus and method of filtration control according to the defining preamble of Claim 10, *whereby* means to control the filtration operation consist of a gas flow controller, a gas throttling valve and a gas pressure controller connected in series from a source of compressed gas to the turbid liquid chamber (5) , *thereby characterized*, that the said means are employed to measure the *permeability* of any filter media before or during any liquid filtration or purification operation by introducing and filtering a volume of liquid of *known* quality to the turbid liquid chamber.

16. Apparatus and method of liquid purification control according to Claim 15, *thereby characterized*, that the *quality* of the turbid liquid and filtrate are determined by instrumentation such as (13/14), whereby optionally the data is fed to a microprocessor/process controller (15) to choose and implement the supply of the optional filter medium before or during any liquid purification operation.

17. Apparatus and method of liquid purification control according to Claims 11 - 16, *thereby characterized*, that the optimal *mode* of purification such as direct filtration by textiles, membranes, non-woven material, precoat filtration, deep-bed purification with or without active powdered material, etc. is determined before or during any liquid purification operation.

18. Apparatus according to the defining preamble of Claim 10, *whereby* the means for engaging and disengaging the upper and lower surfaces of the upper cover and lower receptacle consist of laterally positioned fluid driven pistons (304) contained in cylinders (305), the bodies of which are fixed to a load-bearing framework with the

external extremity of the lubricated shafts (307) connected to sectioned sleeves (301) extending and fixed to the extremities of transverse beams (308) acting on the peripheral part of the upper container (5), *whereby* to ensure movement of the dependent rim portion(s) in the horizontal position, sections of material such as polytetrafluorethylene (302) are fixed to the surfaces of the bodies of the fluid driven cylinders (305) fitted in the space between the cylinder surfaces and the internal surfaces of the reciprocating sleeves (301).

19. Apparatus according to the defining preamble of Claim 10, *whereby* the receptacle for filtered liquid located beneath the porous support surface consists of a recessed plate (505) containing one or a plurality of manually removable medium supporting drainage members (502) preferably consisting of an upper perforated sheet (503) lying flush with the peripheral sealing portions of the plate (505) and integrated with a lower layer or layers of material such as woven mesh or expanded metal sheet (504).

20. Apparatus according to the defining preamble of Claim 10, *whereby* the means for transporting the filter residue in the form of a band is driven by a motor or actuator (702) provided with the facility for reversing the direction of transport of the band to discharge the filter bed or residue at either end of the purifying apparatus.

PATENT COOPERATION TREATY

PCT

NOTIFICATION OF THE RECORDING
OF A CHANGE(PCT Rule 92bis.1 and
Administrative Instructions, Section 422)

From the INTERNATIONAL BUREAU

To:

MILLER, Peter, Anthony
See Strasse 27
D-71229 Leonberg
ALLEMAGNE

Date of mailing (day/month/year) 12 June 1998 (12.06.98)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference	
International application No. PCT/AU96/00442	International filing date (day/month/year) 05 August 1996 (05.08.96)

1. The following indications appeared on record concerning:

☒ the applicant ☒ the inventor ☐ the agent ☐ the common representative

Name and Address

MILLER, Peter, Anthony
91 Bunya Park Drive
Eatons Hill, 4037
Australia

State of Nationality

AU

State of Residence

AU

Telephone No.

Facsimile No.

Teleprinter No.

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

☐ the person ☐ the name ☒ the address ☐ the nationality ☒ the residence

Name and Address

MILLER, Peter, Anthony
See Str. 27
D-71229 Leonberg
Australia

State of Nationality

AU

State of Residence

DE

Telephone No.

07152 902334

Facsimile No.

07152 902234

Teleprinter No.

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

<input checked="" type="checkbox"/> the receiving Office	<input type="checkbox"/> the designated Offices concerned
<input type="checkbox"/> the International Searching Authority	<input checked="" type="checkbox"/> the elected Offices concerned
<input checked="" type="checkbox"/> the International Preliminary Examining Authority	<input type="checkbox"/> other:

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer

Marie-José Devillard

Telephone No.: (41-22) 338.83.38

PATENT COOPERATION TREATY

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

United States Patent and Trademark
Office
(Box PCT)
Crystal Plaza 2
Washington, DC 20231
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 12 June 1998 (12.06.98)	
International application No. PCT/AU96/00442	Applicant's or agent's file reference
International filing date (day/month/year) 05 August 1996 (05.08.96)	Priority date (day/month/year)
Applicant MILLER, Peter, Anthony	

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:

27 February 1998 (27.02.98)

☐ in a notice effecting later election filed with the International Bureau on:2. The election ☒ was☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No.: (41-22) 740.14.35	Authorized officer Marie-José Devillard Telephone No.: (41-22) 338.83.38
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